3B SCIENTIFIC® PHYSICS

Set of 3 Metal Block Calorimeters 1025440 + Metal Block Calorimeter Brass 1025441

Instruction Sheet

11/24 HJB

❶ Calorimeter, Steel

❷ Calorimeter, Copper

❸ Calorimeter, Aluminum

❹ Calorimeter, Brass

1. Safety instructions

There is a risk of burns from heater or calorimeter.

- Allow apparatus to cool before moving it.

2. Description

The set of 3 metal block calorimeters and the metal block calorimeter of brass are used to determine the specific heat capacity of aluminum, brass, copper and steel.

The metal blocks are drilled with two holes to accommodate a heating element (12.5 mm diam.) and a thermometer or temperature probe (8 mm diam.).

3. Technical data

Mass of block: approx. 1 kg (±2 % accuracy)

Material	Height (mm)	Diameter (mm)	Specific heat J/(kg*K)
Aluminum	84	75	896
Brass	84	44	377
Copper	85	43	385
Steel	92	44	452

4. Additional required equipment

1 DC Power Supply 20 V, 5 A @230 V, 50/60 Hz 1003312

or

1 DC Power Supply 20 V, 5 A @115 V, 50/60 Hz 1003311

1 Heating Element, 12 V 1025439
1 Thermometer, -10°C to +110°C 1002879
1 Digital Stopwatch 1002811

5. Operation

- Weigh the calorimeter block and record its mass.
- Place the calorimeter block on a heat proof mat surrounded by insulation, so that the heat losses are kept to the minimum.
- Insert the heating element and the thermometer into the appropriate hole. Drop some oil or water into the thermometer hole to ensure good thermal contact between the thermometer and the block.
- Set up the circuitry according to Fig. 1.
- Switch on the power supply and adjust it to give a current of about 4 A. Switch the heater off.
- Before starting the experimental run, wait for a few minutes before taking the temperature of the calorimeter block.
- Switch on the heater and start the clock.
- Wait until the temperature has risen about 20°C and record the time and final temperature.

The specific heat capacity can then be calculated from the equation:

$$I \cdot U \cdot t = m \cdot c \cdot (\theta_2 - \theta_1) \qquad (1)$$

with *I*: current, *U*: voltage, *t:* time, *m*: mass of calorimeter block, *c:* specific heat capacity, θ_1: initial temperature, θ_2: final temperature

6. General notes

6.1 Explanation of how to minimize the error

Assuming that the readings for the current and voltage are reasonable accurate, the two main sources of error in the experiment will be the readings of the temperature change and the effects of any heat loss.

Obviously, the heat loss will depend on the excess temperature above the room temperature, so this can be minimized by keeping the temperature rise as small as possible.

If the thermometer can only be read accurately to 1°, then a temperature rise of 10° would give a 10% error, which is really too large for this type of experiment. Therefore, it is a balance between the error introduced by a large temperature increase causing heat losses, and a small temperature increase giving a large percentage error in the temperature readings. A 20° rise in temperature will give a 5% error in reading the thermometer (assuming it can only be read accurately to 1°) and a reasonable low error due to heat loss.

6.1 Rumford’s correction

Rumford argued that heat losses could be eliminated by the following process. If the metal block is kept in a fridge for several hours before the experiment, then it will start at, say, θ below room temperature. If its final temperature after the experiment was θ above room temperature, then the heat it took in while below room temperature would be equal to the heat it gave out while above room temperature, so there would be no heat loss.

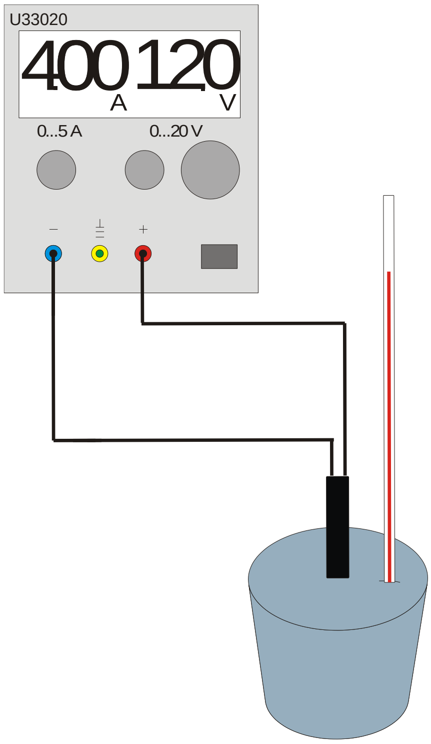

Fig. 1 Experimental set up